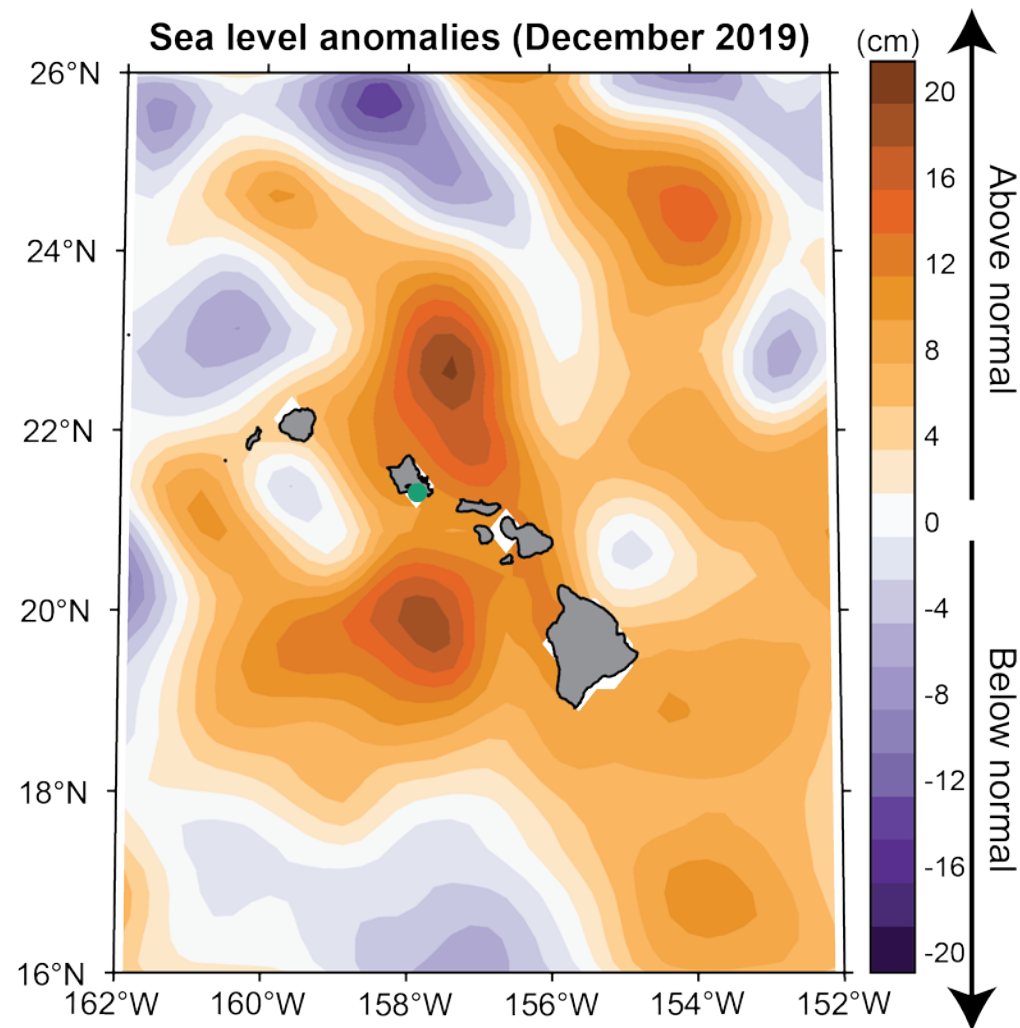
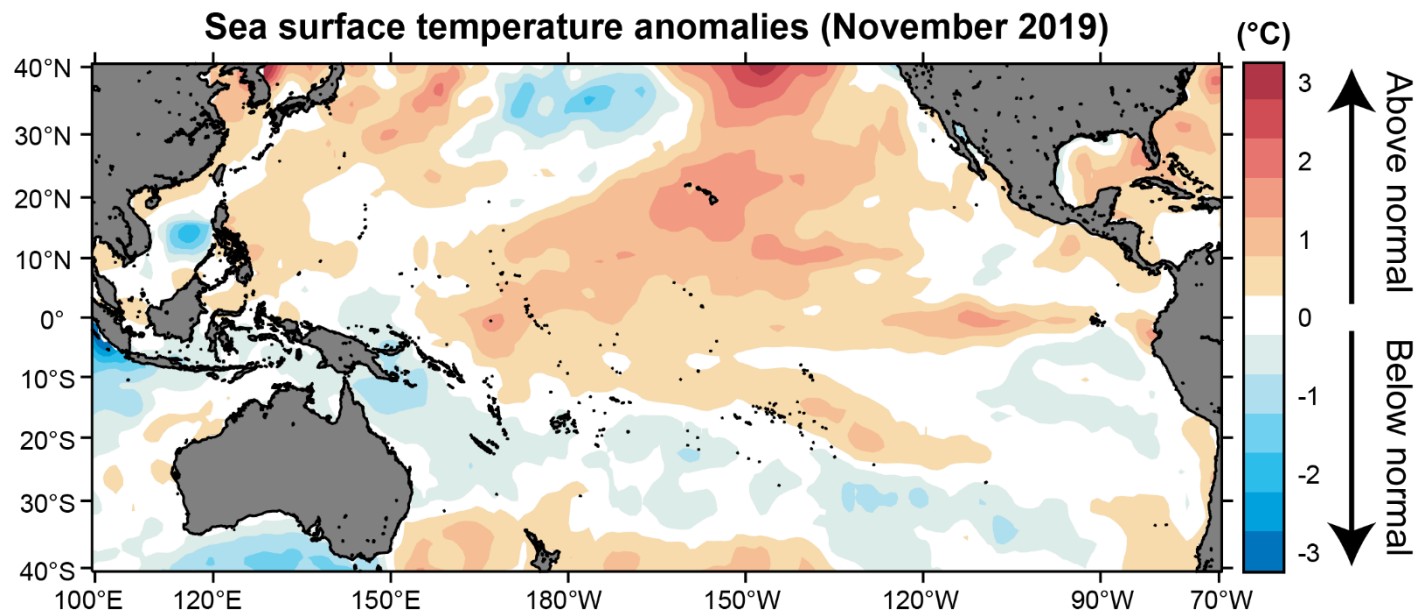


# Forecasting the next hot summer and high sea levels for Hawaii



**Matthew Widlansky**

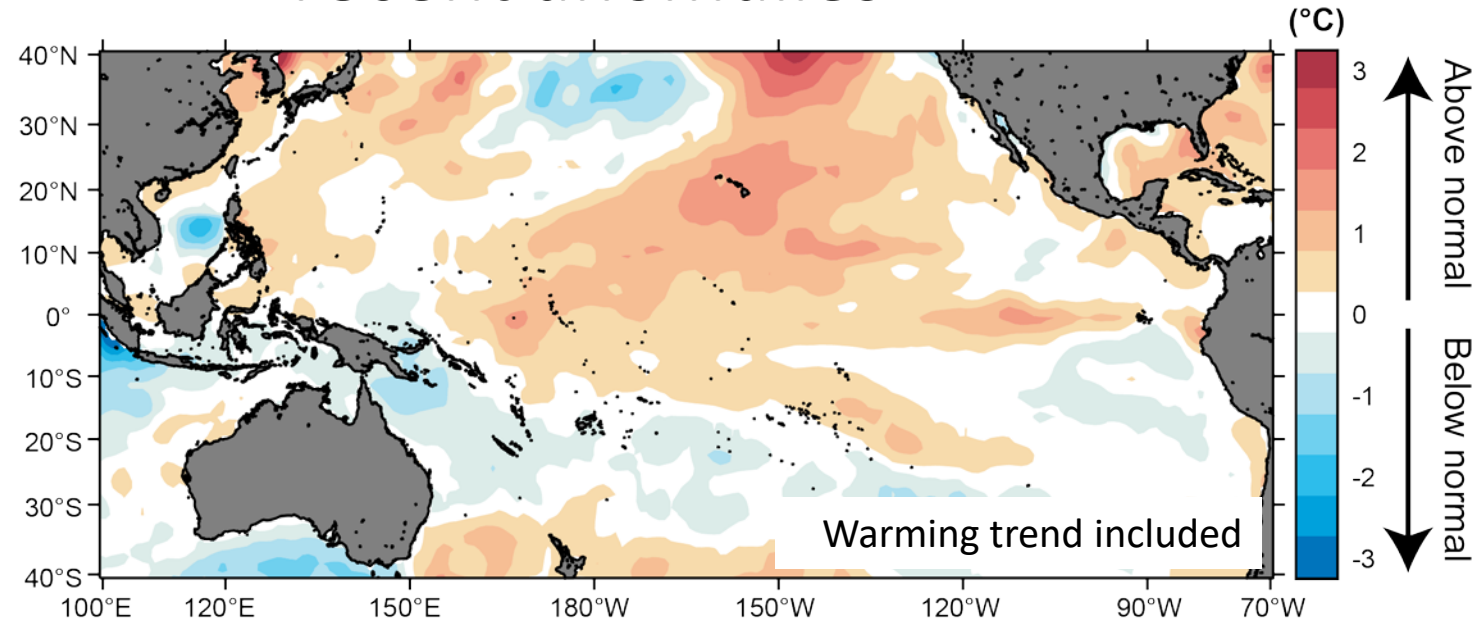
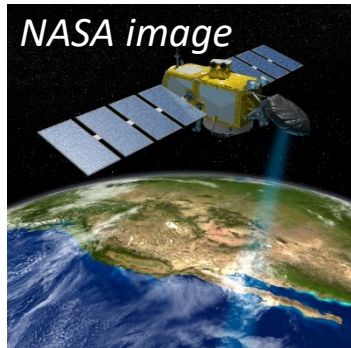


With support from:

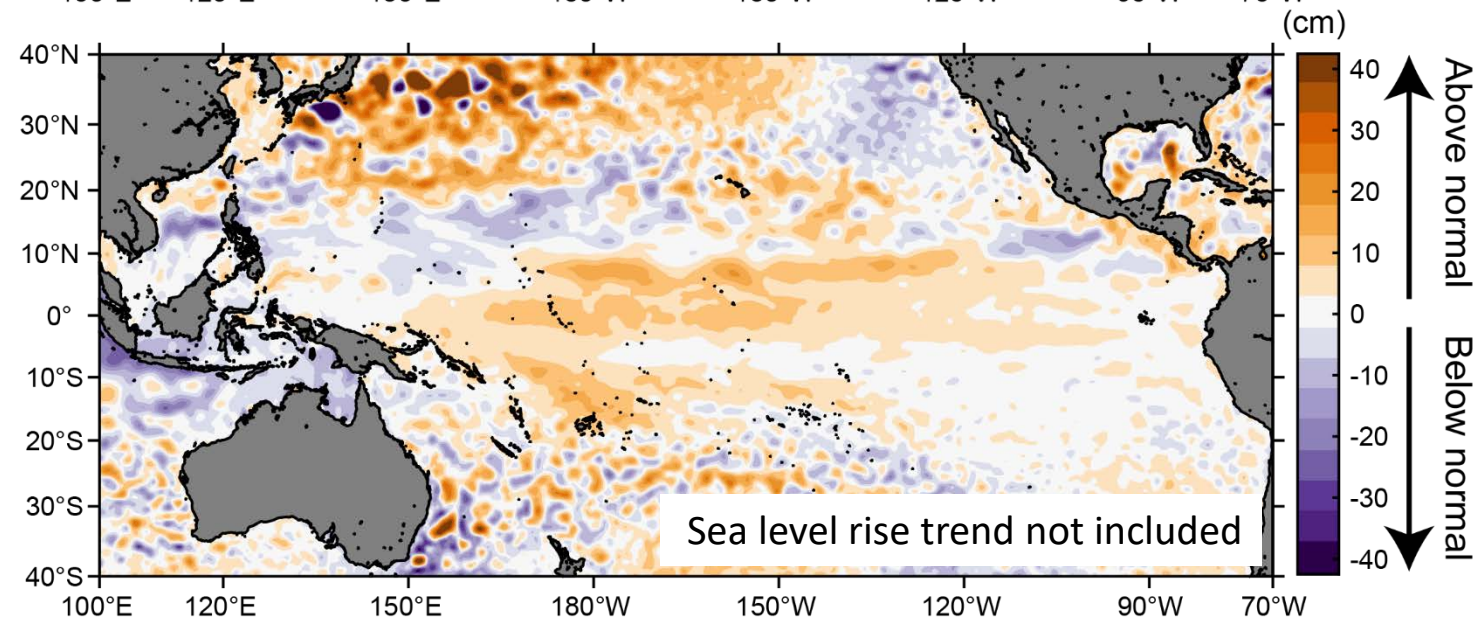


# Pacific-wide patterns of Sea Surface Temperature and Sea Level recent *anomalies*

**Sea surface temperature**



**Sea surface height**



# Climate anomaly defined

**We are interested in departures from “Normal”**

$$\text{Anomaly} = \text{Observation} - \text{Climatology}$$

For example,

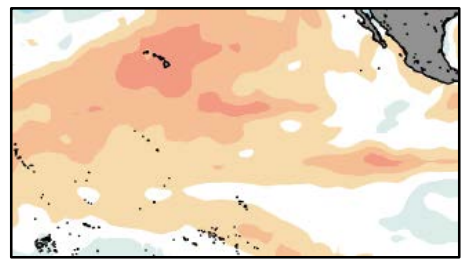
$$\text{Anomaly}_{\text{December 2019}} = \text{Observation}_{\text{December 2019}} - \text{Climatology}_{\text{December 1993–2019}}$$

That is,

if a month is **warmer** or **higher** than normal, the anomaly is **positive**.

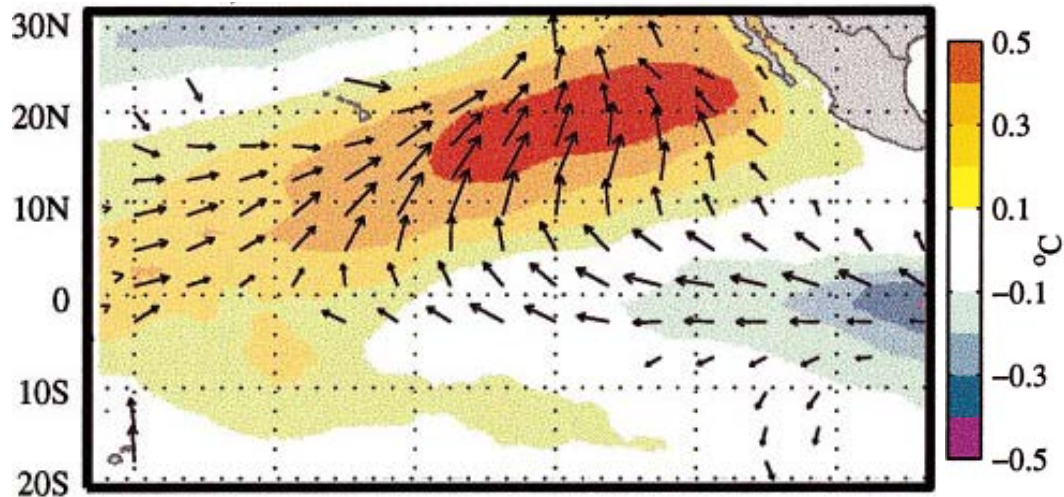
# Physical explanation

## for warmer-than-normal central Pacific Ocean



1

Weak trade winds and warm ocean surface

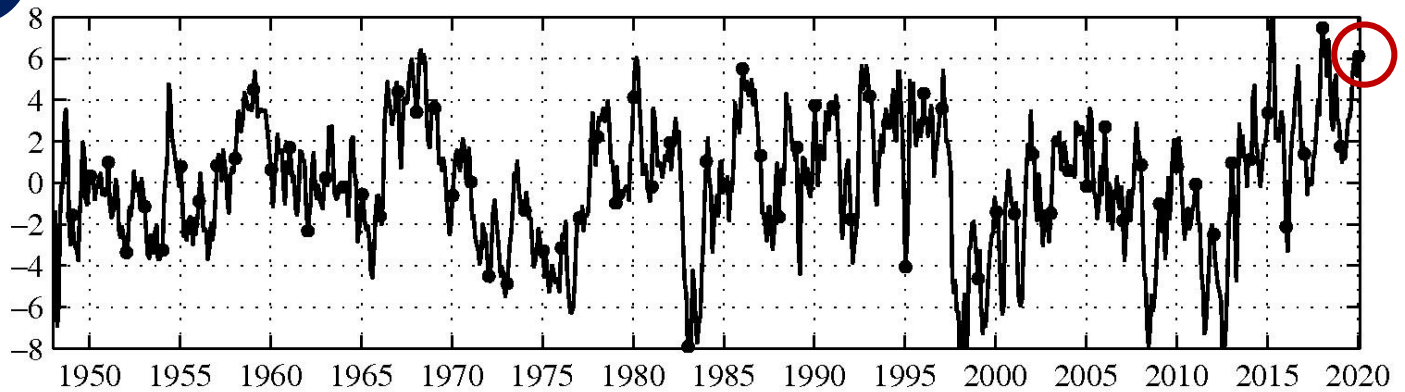


2

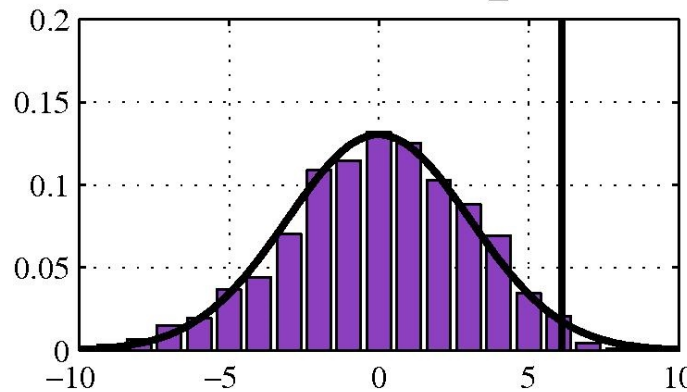
Air-sea pattern of variability called the **Pacific Meridional Mode (PMM)**

3

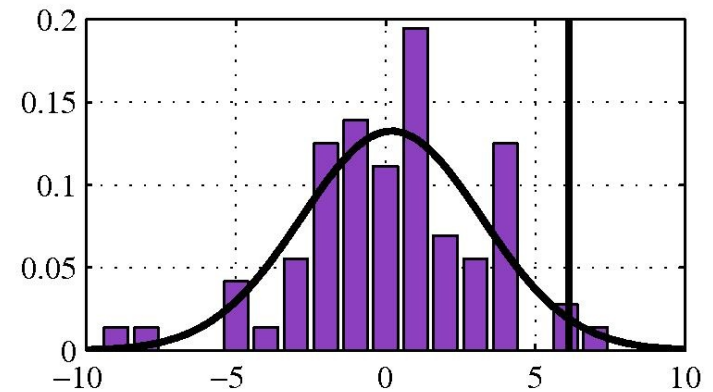
PMM Index (SST based): Dots denote DEC values



PMM Distribution: ALL\_MON = 97.7%

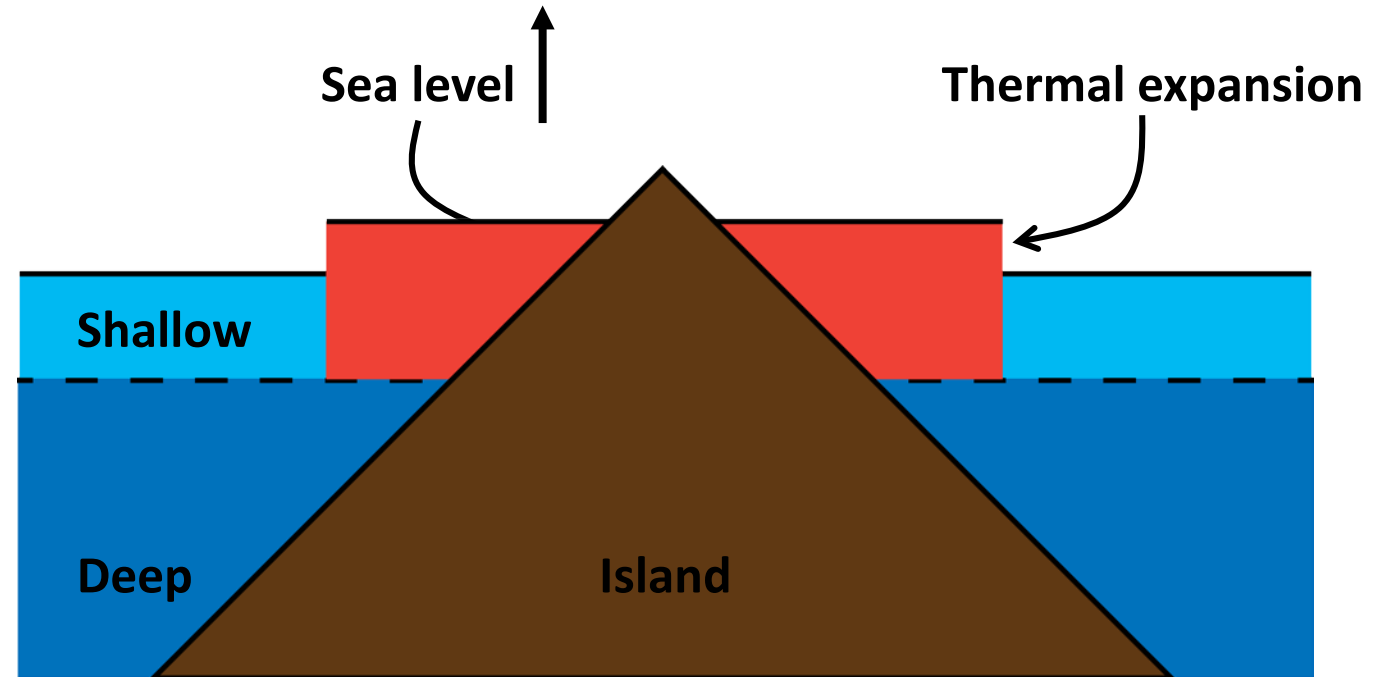
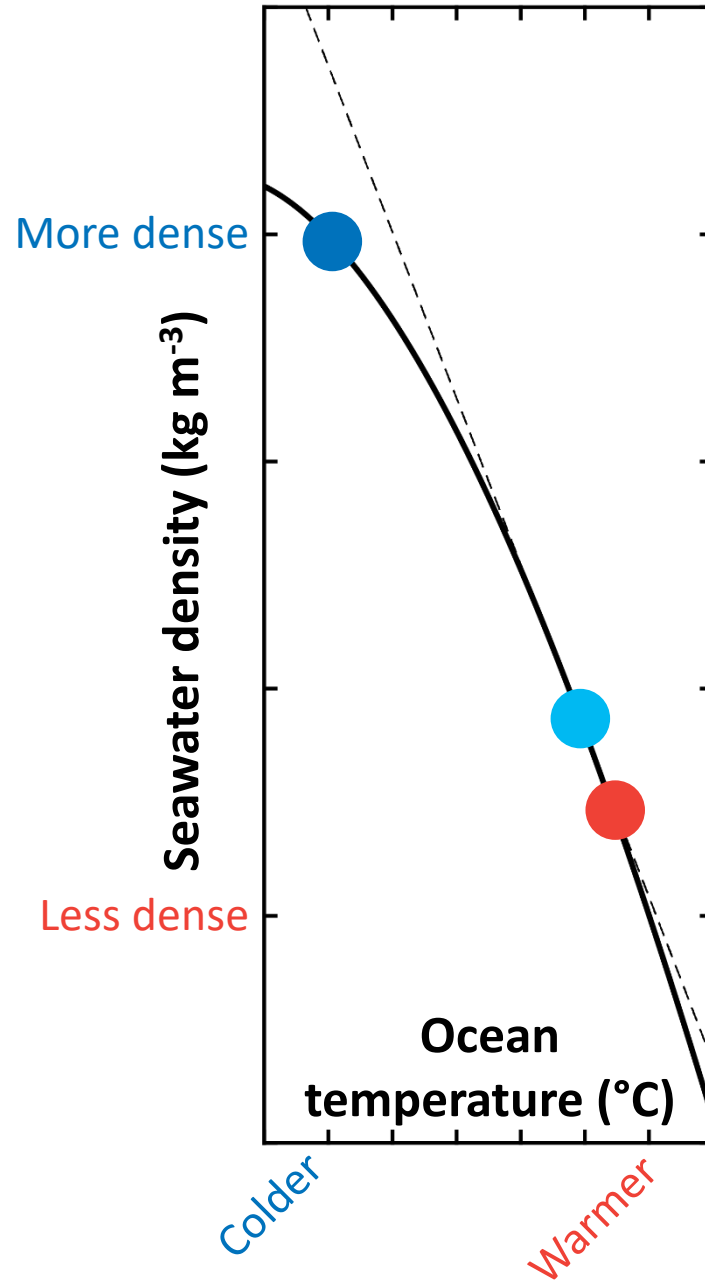


PMM Distribution: DEC = 97.5%

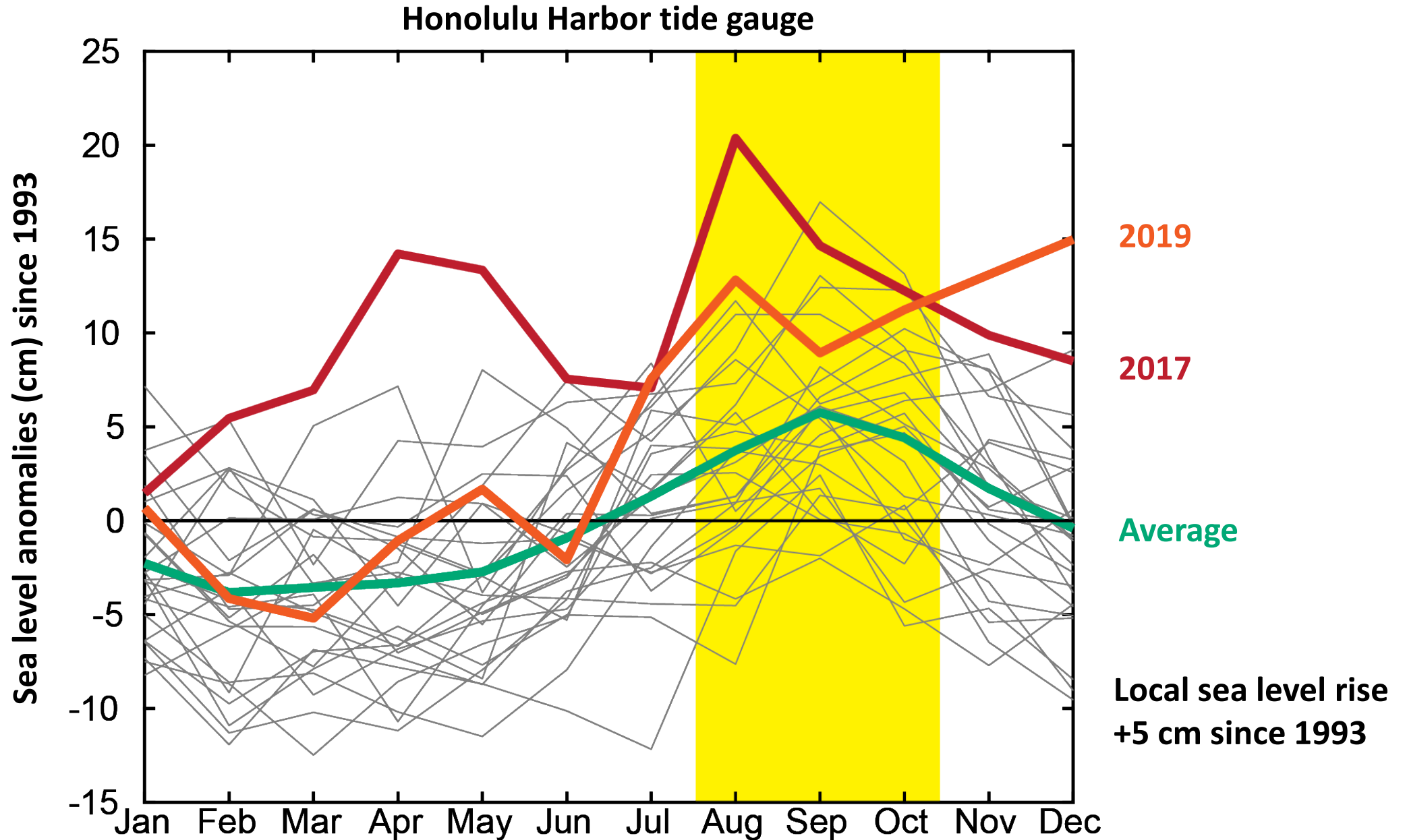


Chiang, J. C. H. and D. J. Vimont, 2004: Analogous meridional modes of atmosphere-ocean variability in the tropical Pacific and tropical Atlantic. *J. Climate*, 17 (21), 4143–4158.

# Warm ocean temperatures and high sea levels are physically related



# Annual cycle and year-to-year variability of Hawaii sea levels

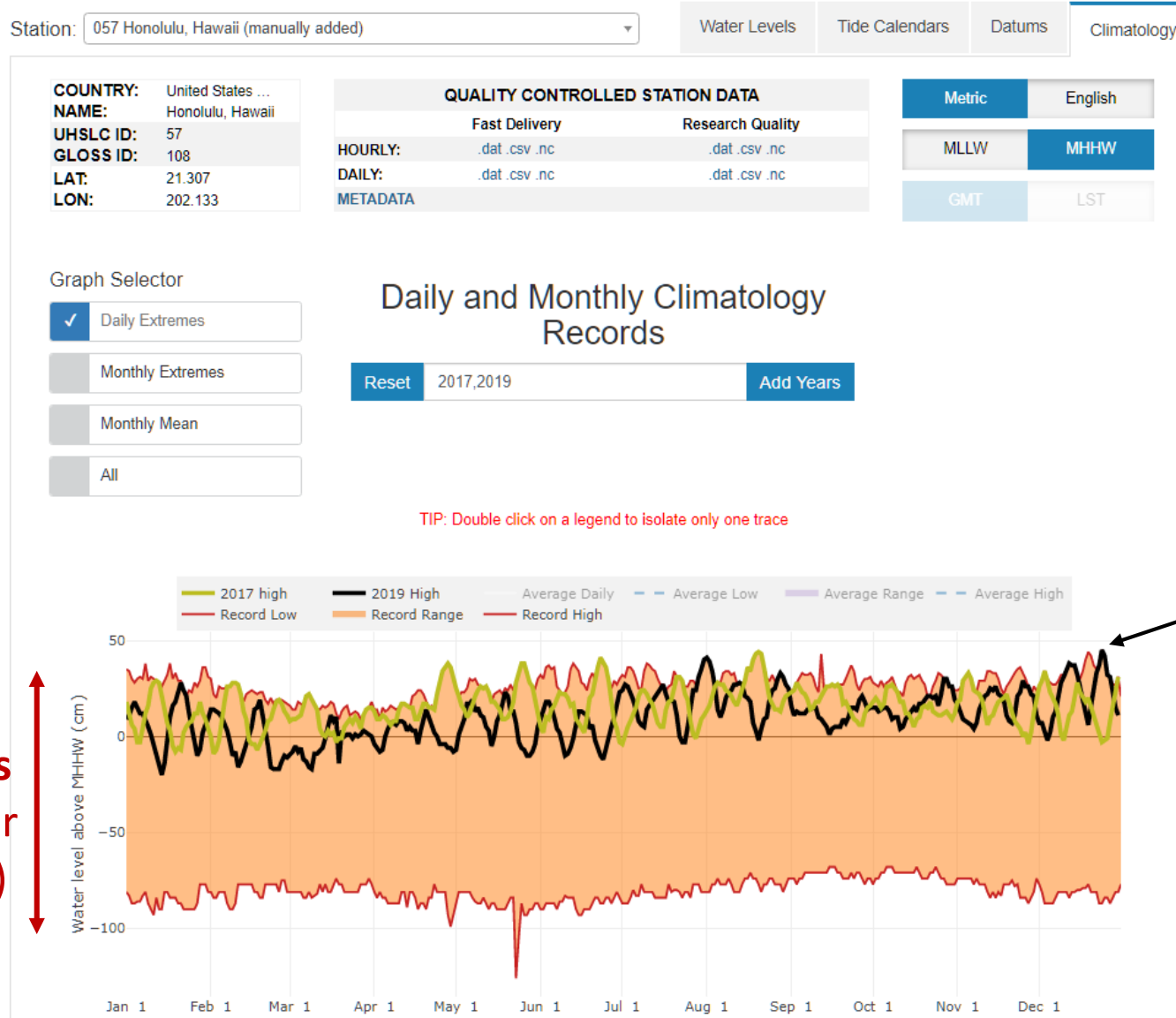


# Record high water levels in Hawaii

New product



STATION EXPLORER



## Honolulu Tide Gauge

**December 25, 2019**  
Highest hourly water level since 1905.

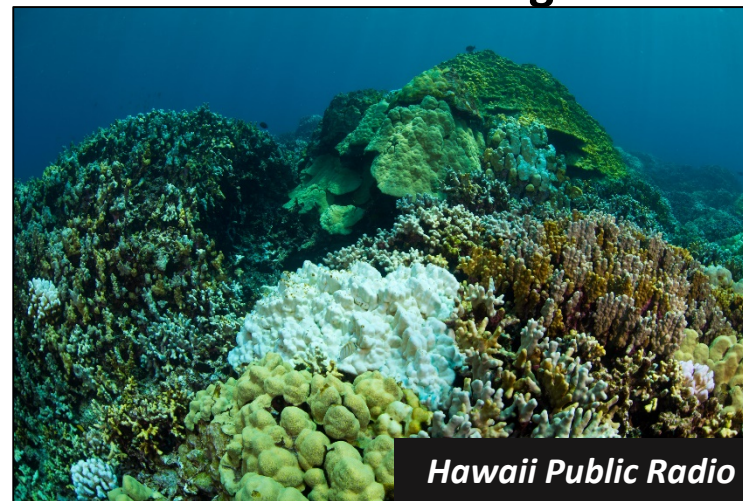
**Record high & low water levels**  
(relative to Mean Higher High Water "high tide")

# Impacts of high sea levels and warm ocean temperatures

**Coastal erosion**



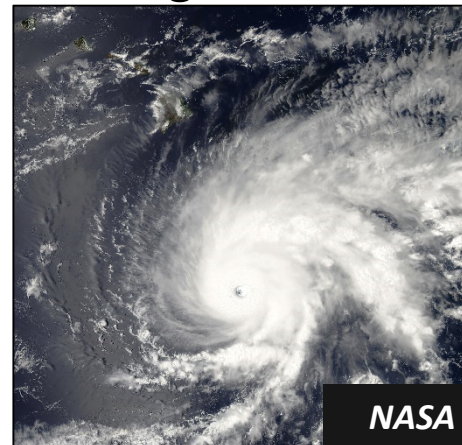
**Coral bleaching**



**Wave run up**



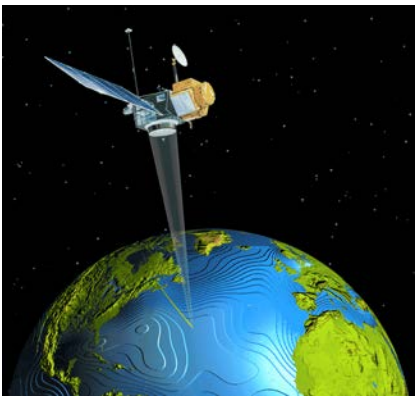
**Strong hurricanes**



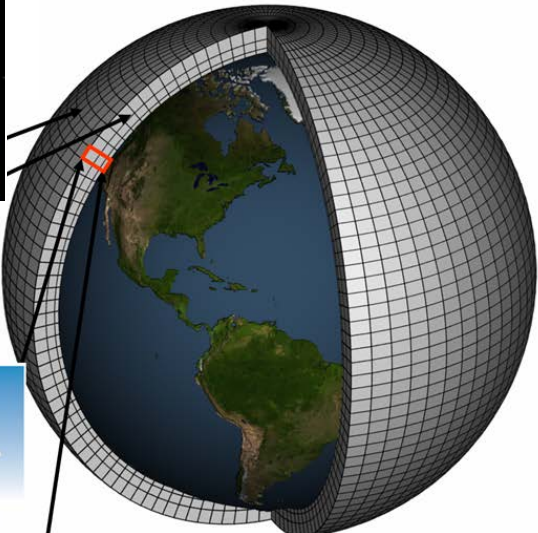
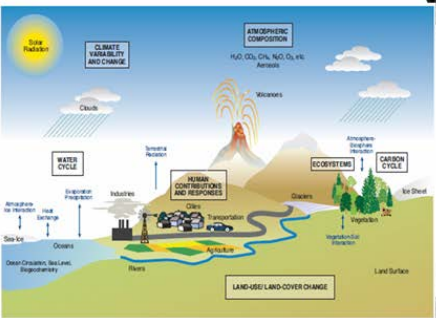
**Opportunity for future outlooks (forecasts)  
of climate anomalies to benefit society**



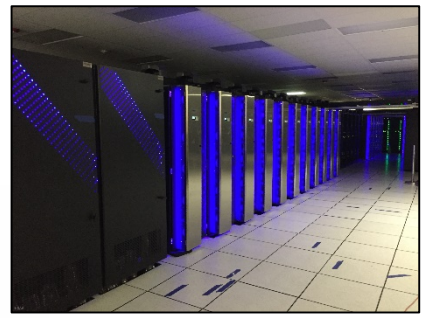
# Pathway to making a seasonal climate forecast



Forecasts start from observations.



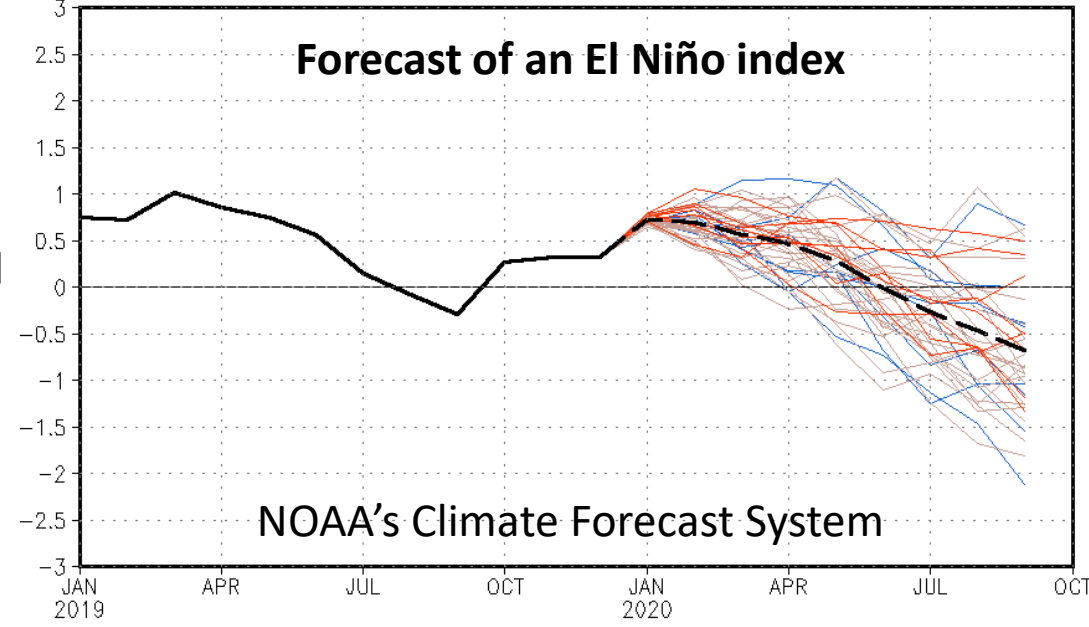
Computer code to solve equations of physical processes.



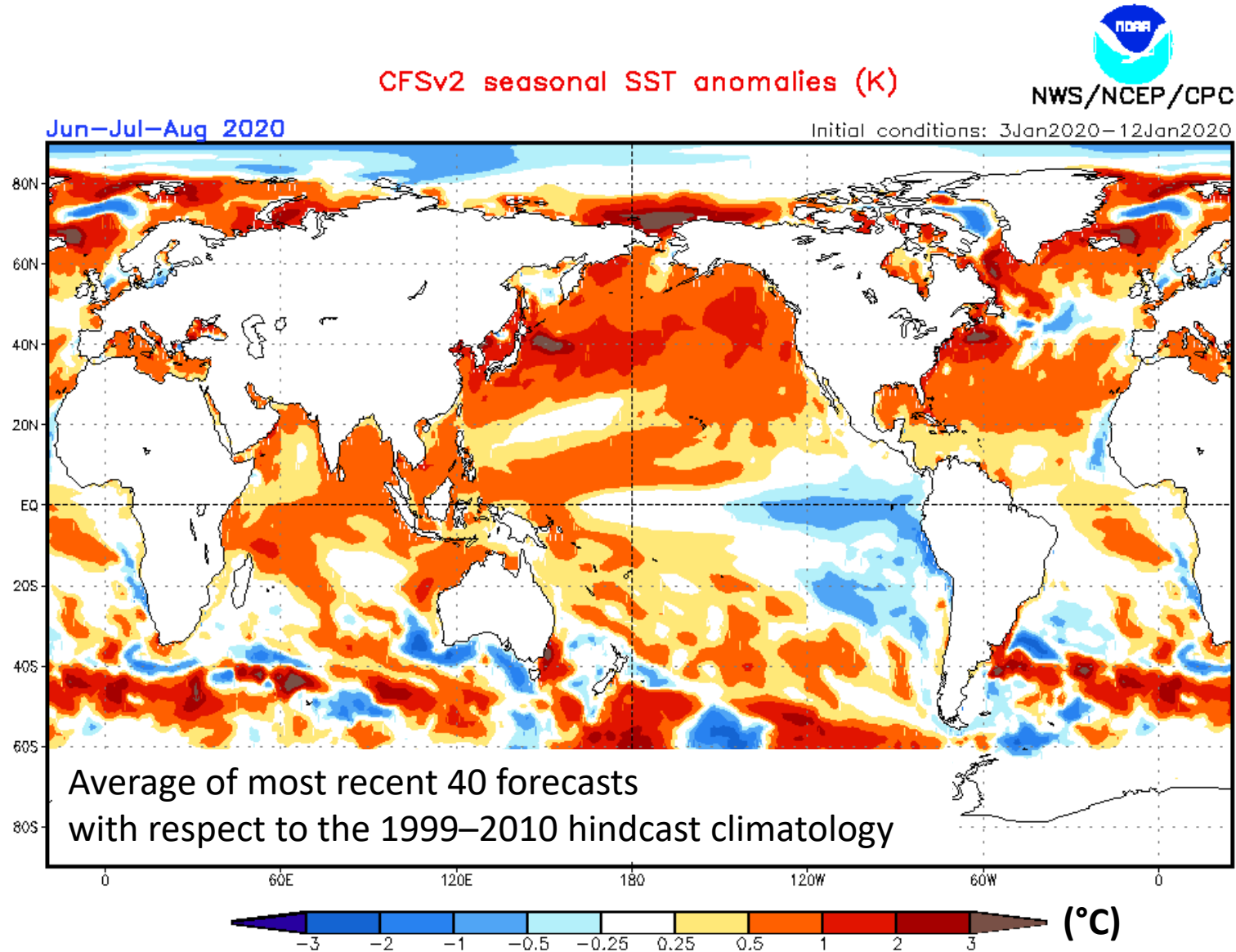
NOAA's weather and climate computing system can perform > **8 quadrillion ( $10^{15}$ ) calculations per second (petaflops).**

Many simulations (ensembles) are assessed to **calculate skill** compared to past observations and statistically adjusted.

- Interpretation?
- Application?
- Uncertainty?



# NOAA Climate Prediction Center's Sea Surface Temperature forecast for summer 2020



Warmer than normal  
for Hawaii

# Monthly processing of sea level forecasts for tropical Pacific Islands

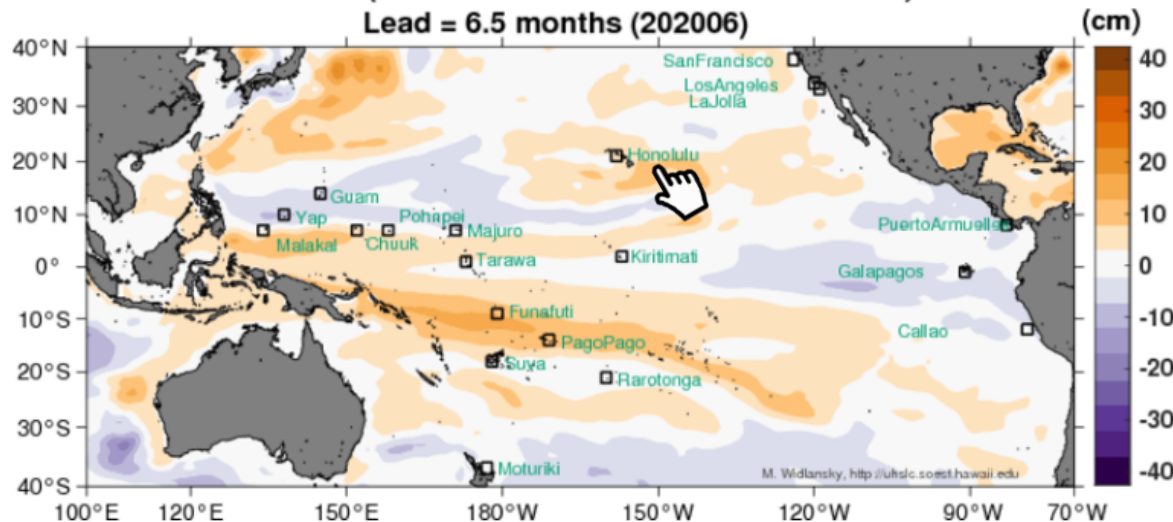
This product provides an outlook of monthly sea level anomalies for the next one to two seasons. We combine sea level forecasts with astronomical tide predictions to provide more accurate predictions of coastal water level compared to tide predictions alone.

[READ MORE](#)

This seasonal forecast product is *experimental*. For short-term forecasts (daily to weekly), please see the [High Sea Level Forecast](#) for your region. Neither the seasonal nor the weekly product is accurate when a [tsunami](#) or [tropical cyclone](#) threatens your coastline.

## June 2020 forecast of sea level anomalies

Model forecast (CFSv2: initialized 20191202-20191231)  
Lead = 6.5 months (202006)



Mouseover for past and future months.

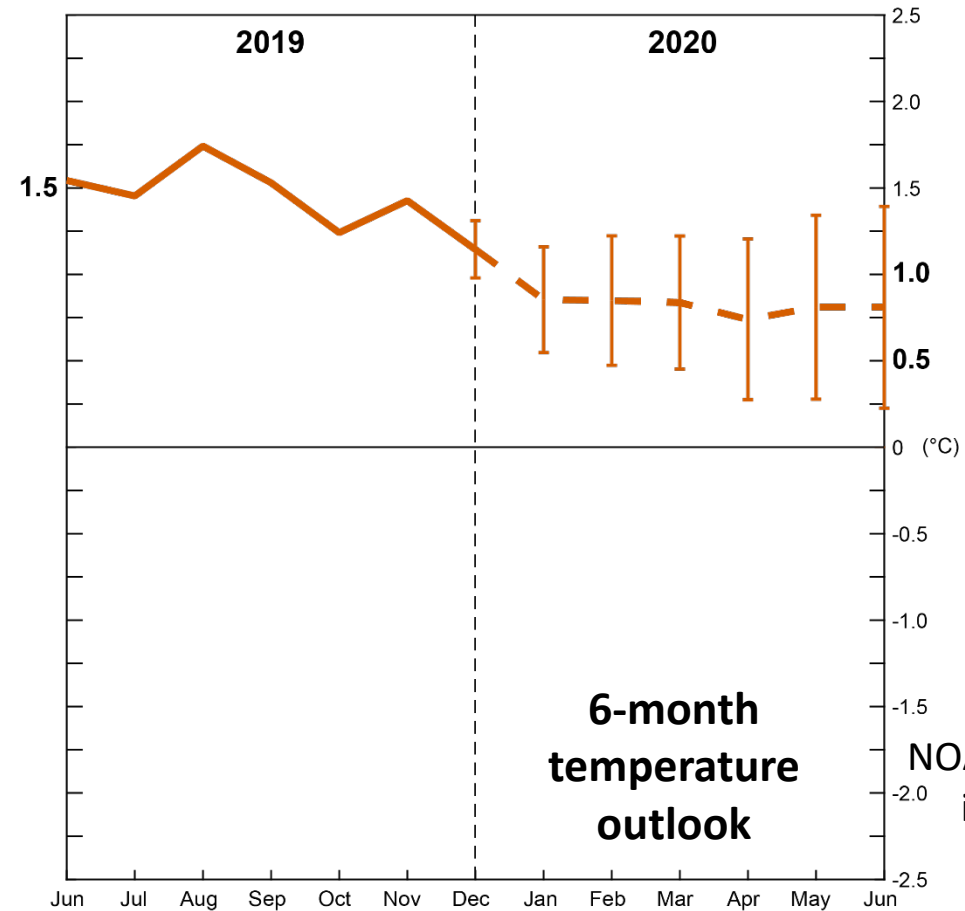
- Click for
- 1) Island forecasts
  - 2) Tide predictions
  - 3) Forecast discussion

### How to use this page ...

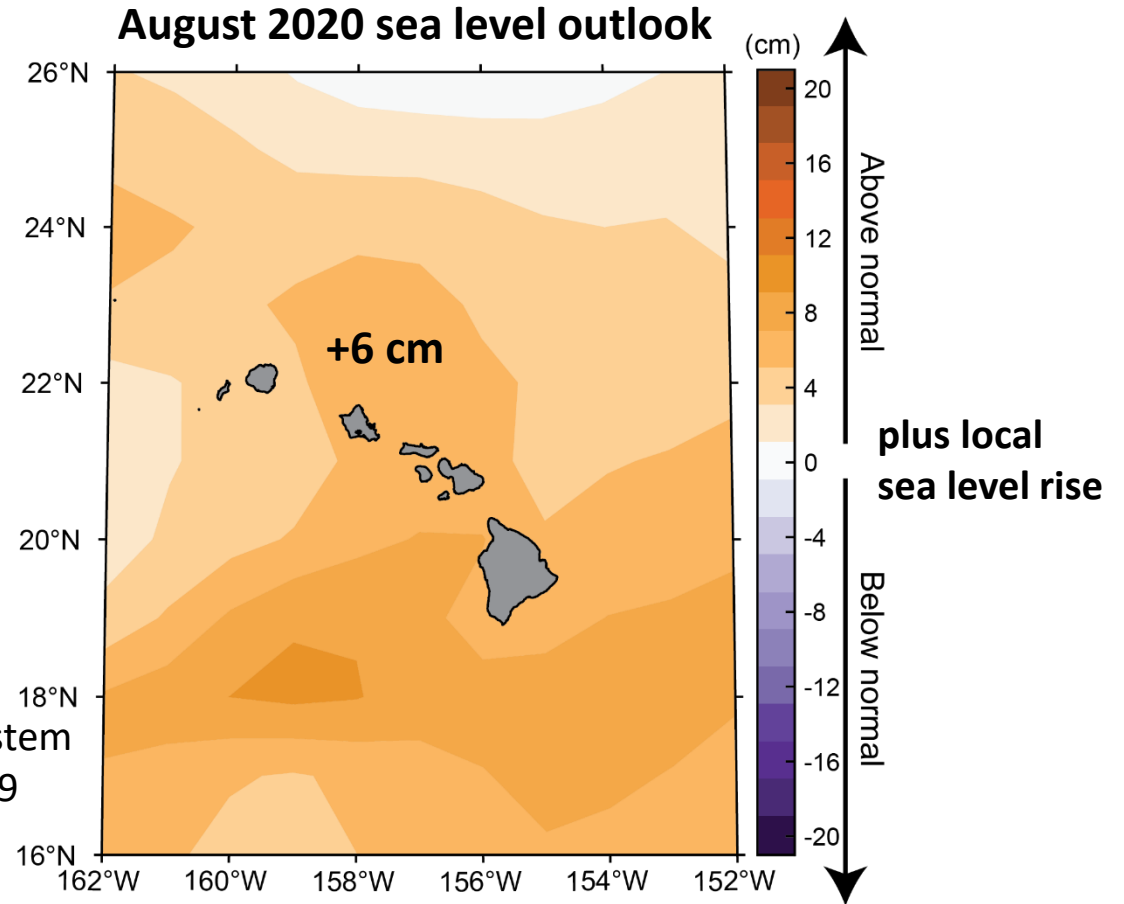
- Visualize recent sea level observations from satellites (past 6 months) and predictions from one model (next 6 months) by moving the mouse over the row of numbers below the map.
- View multi-model forecasts for many islands in the tropical Pacific by clicking tide gauge station labels on the map.
- Click on the "Tides" or "Impacts" tabs to see how the predicted relative sea level anomaly is likely to alter the astronomical tide cycle and affect the coastline.

<http://uhslc.soest.hawaii.edu/sea-level-forecasts/>

# Above-normal surface temperatures and sea levels are forecast around Hawaii through summer 2020



6-month temperature outlook  
Data from NOAA's Climate Forecast System initialized December 2019



**Thank you**

**Matthew Widlansky**  
*mwidlans@hawaii.edu*

